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Small intestinal biopsy and resection in standing sedated horses

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Summary

Diagnostic laparotomy and laparoscopy are surgical techniques commonly used for the investigation of chronic abdominal disease and weight loss. They can both be usefully carried out in the standing sedated horse, allowing a thorough examination of the dorsal abdominal cavity and biopsies to be harvested. Small intestinal disease is an important cause of weight loss and recurrent colic. Inflammatory or neoplastic bowel disease may not always be apparent grossly and histopathological assessment of full thickness biopsies may be required to provide a definitive diagnosis. A series of 15 horses are described that underwent small intestinal biopsy or enterectomy under standing sedation. Three incisional complications occurred causing delayed wound healing. Three horses were euthanized before hospital discharge: two had persistent gastric reflux and one had colitis. A further 6 were euthanized in the first 4 months due to their underlying inflammatory bowel condition. One horse was euthanized for severe laminitis that was presumed to be caused by treatment with a corticosteroid 4 years later, and one died of acute colic 2.3 years after successful resection and anastomosis. Five horses were alive at the time of review, median 2.7, range 1.2 to 4.3 years. Overall therefore, three (20 %) horses died during hospitalization and 5 (33 %) were still alive at the end of the study. Results from this series suggest that minimising the number of biopsies may reduce morbidity, but the underlying pathological process appears to be the most important prognostic factor for survival. Resection and anastomosis in the standing sedated horse proved feasible.

Background

Chronic weight loss and recurrent colic are commonly encountered signs of abdominal disease (Mair 2002; Mair and Divers 2008). Diagnostic investigations can be complex and obtaining a definitive diagnosis in some cases requires surgical abdominal exploration, either by laparotomy or laparoscopy (Ragle 2002; Klohn 2012). Diagnostic laparoscopy in the standing horse has become increasingly popular as it combines all of the advantages of minimally invasive surgery and provides a unique view of the dorsal abdominal cavity (Ragle 2002). However, it is a specialist procedure with relatively poor specificity (Walmsley 1999). Although the diagnostic information obtained may be invaluable, owners can be wary of the procedure because of the difficulty in treating any problems identified.

Whether or not gross abnormalities are noted, obtaining intestinal biopsy samples for subsequent histopathology can allow an otherwise elusive diagnosis to be made. Prognosis can then be given and a treatment plan formulated (Mair 2002; Trachsel et al 2010). The aim of this study was to review the technique, complications and outcome of a small series of horses that underwent extra-abdominal small intestinal surgery under standing sedation, involving either the harvesting of full-thickness intestinal biopsies, or resection and anastomosis.

Methods

Horses were starved for 36 hours prior to surgery, where possible. They were restrained and sedated in stocks using a bolus intravenous dose of detomidine (0.02 mg/kg) and butorphanol (0.02 mg/kg), followed by further incremental doses of detomidine supplied either as a repeat bolus, or as a constant rate infusion (20 µg/kg/hr). Prophylactic procaine penicillin (22,000 IU/Kg bodyweight) and flunixin meglumine (1.1 mg/kg bodyweight) were administered 60 minutes prior to performing a skin incision. In 7 horses only the left paralumbar fossa was prepared for standing laparotomy; in a further 8 horses both paralumbar fossae were clipped and prepared for aseptic laparoscopic surgery. Skin and muscle layers were anaesthetised by infiltration of mepivacaine hydrochloride at the proposed incision sites (15 ml of 2 % solution per site) after aseptic skin preparation.

Three surgeons carried out all 15 procedures. One surgeon carried out 7 unilateral left-sided laparotomies with a representative section of small intestine selected blindly after palpation. Laparotomy was carried out by means of a standard 7 to 12 cm long gridiron incision (Hendrickson 2007, Graham and Freeman 2014). In the 8 bilateral surgical procedures, routine diagnostic laparoscopy was first performed on both sides, with one side prepared for laparotomy; two surgeons used the left side in 4 horses and one surgeon used the right side in 4 horses. A single portal was placed in the left paralumbar fossa level with the ventral tuber coxa. The first instrument port was orientated vertically below the scope portal; the third placed in the 17th intercostal space. One surgeon used these two instrument ports to 'walk' the entire length of the small intestine using atraumatic laparoscopic bowel grasping forceps¹ in one horse. To find the proximal end of the jejunum the ascending duodenum was traced from its medial attachment to the caecum. After a brief assessment in 7 horses, two surgeons linked the paralumbar ports to create a grid laparotomy incision and then subsequently used a hand-assisted technique to examine the whole length of the small intestine.

The section of intestine for biopsy was selected and manipulated using instrumentation, or by hand, before being exteriorised via the laparotomy wound (Figure 1). Having exteriorised the small intestine (Figure 2), a routine antimesenteric full-thickness biopsy was obtained using conventional instrumentation (approximately 8 x 20 mm). The resultant defect was repaired using a continuous single layer Cushing inverting suture pattern using 2 metric braided polyglycolic acid² or monofilament poliglecaprone 25³. After lavage, the intestine was replaced and further biopsies obtained in the same manner, as required. No local anaesthetic was applied to the intestine before biopsy or resection.

Intestinal resection was carried out via the same laparotomy technique. The portion of intestine to be resected was exteriorised and supported by an assistant surgeon (Figure 3). Following resection, a standard 2-layer hand sewn end-to-end anastomosis was performed (McIllwraith & Robertson 1998), comprising of a continuous mucosal closure followed by a continuous inverting Cushing's pattern incorporating the submucosa² (Figure 4).

Short-term complications were defined as those occurring as a direct result of the surgical intervention. Long-term follow-up was obtained by re-examination and telephone interview with the owner. Data were collated and descriptive statistics calculated using a standard spreadsheet³.

Results

Fifteen horses underwent surgery in the period 2005 to 2014: 6 mares and 9 geldings aged 6 to 25 years, mean and median 15 years. There were 7 Thoroughbred & crosses, three warmbloods, three ponies and two cobs. Twelve horses were presented for weight loss, one for pyrexia of unknown origin, one for recurrent colic and one for acute colic.

Seven horses underwent unilateral left flank laparotomy without a preceding laparoscopic evaluation because this was not available at the time. Eight horses underwent initial diagnostic laparoscopy; the subsequent laparotomy was carried out in the left flank (4 cases) and right flank (4 cases). The median number of biopsies taken was three, range one to 4. The diagnosis in 13 of the horses was inflammatory bowel disease, including the horse with pyrexia of unknown origin: 9 were classified as lymphoplasmacytic and 4 as eosinophilic enteritis, a ratio approximately 2:1. Amongst the 8 horses undergoing laparoscopy, the visual appearance of biopsied sections of bowel appeared abnormal in 4 horses (thickened/inflamed bowel wall) and normal in 4. One biopsy each was harvested in the 4 horses with abnormal intestine; the 4 horses with normal-appearing intestine had one, two, three and three biopsies harvested, with choice governed by the surgeon. The number of diagnostic, as opposed to normal, biopsies harvested was not recorded.

Small intestinal resection and end-to-end anastomosis was carried out under standing sedation in two horses. The principle technical difficulty encountered was minimising exposure of normal bowel adjacent to the section undergoing resection and anastomosis. In one horse with acute colic, resection was undertaken for purely financial reasons as a 'last resort'. The horse had been showing evidence of colic for 36 hours and was clinically demonstrating signs of systemic inflammatory response syndrome (SIRS) (heart rate 80 beats per minute, mucous membranes congested, capillary refill time three seconds, hematocrit 58 %). One metre of jejunum was resected after strangulation by a pedunculated lipoma. In the other case of intestinal resection, the horse had advanced paraneoplastic syndrome with profound weight loss, thus making it an unsuitable

candidate for general anaesthesia (Figure 5). The location and suitability of the 20 cm lesion for resection and anastomosis was determined intra-operatively. Histopathology demonstrated definitive evidence of a highly infiltrative adenocarcinoma, with infiltration of local lymphatics within the submucosa and serosa.

Hospital mortality and morbidity

Three horses underwent euthanasia before hospital discharge as a result of persistent post-operative gastric reflux in two horses and colitis in a third.

The acute colic resection and anastomosis case experienced severe gastric reflux until euthanasia. The other horse with post-operative reflux underwent an elective left flank blind laparotomy and collection of 4 small intestinal biopsies: three jejunal and one ileal. The diagnosis was eosinophilic enteritis. After refluxing for three days it underwent exploratory laparotomy under general anaesthesia, where paralytic ileus was the only finding; the biopsy sites all appeared healthy. Reflux continued after this surgery, necessitating euthanasia after a further three days. No other horses developed gastric reflux. One horse developed acute colitis and severe diarrhoea. This horse underwent euthanasia on day 10 after the condition deteriorated despite intensive treatment.

Of the 11 horses that survived to hospital discharge, three developed wound infections with partial breakdown during the hospitalisation period. All three had undergone blind laparotomy without laparoscopy. They were successfully managed by wound drainage and parenteral antibiotics, with individual drug choice varying due to differences in culture and sensitivity results. The number of biopsies in the horses suffering wound complications was 4, 4 and three; no horses undergoing one or two biopsies developed wound complications

Mortality and morbidity after hospital discharge

Of the 12 horses discharged, 5 underwent euthanasia within 4 months due to on-going inflammatory bowel disease, malabsorption and weight loss: 4 lymphoplasmacytic and one eosinophilic. One horse developed severe laminitis with distal displacement of the distal phalanges

4 years after surgery, with the cause considered to be a complication of oral prednisolone therapy for its inflammatory bowel disease (Johnson et al 2002). The horse that underwent resection and anastomosis for adenocarcinoma gained weight after discharge. However it developed acute severe colic 28 months later and was subject to euthanasia. No post-mortem examination was carried out.

Five horses (33 %) were still alive at the time of writing this paper, three lymphoplasmacytic and two eosinophilic, with a median survival of 2.7 years, range 1.2 to 4.3 years.

Discussion

Obtaining full-thickness small intestinal biopsies in standing sedated horses using the extra-abdominal technique described herein proved expedient from either flank, with or without laparoscopic assistance. Although elegant laparoscopic intra-abdominal intestinal biopsy techniques have been described in the past (Schambourg & Marcoux 2006; Bracamonte et al. 2008), these procedures require the use of advanced laparoscopic intra- corporeal suturing skills or expensive endoscopic linear staplers. Extra-abdominal full thickness biopsy via flank laparotomy has been alluded to in several reviews (Mair 2002; Graham and Freeman 2014), yet there are no published reports citing the use of these techniques clinically. The extra-abdominal technique described herein is more secure in our experience, obviating the need for intracorporeal suturing and thereby negating the risk of peritoneal contamination. Intestinal resection and anastomosis was also carried out successfully by this method, in both cases because general anaesthesia was not possible for either financial or clinical reasons.

Blind flank laparotomies were performed before laparoscopy was routinely available. Subjectively, laparoscopy gave the perception of a more thorough diagnostic examination and manipulation of bowel before laparotomy, potentially increasing the diagnostic value of the procedure. Despite this, the blind technique provided diagnostic samples in every horse. This suggests that the difference between selecting abnormal small intestine by palpation or visualisation was not significant. However, laparoscopy allowed visually abnormal bowel to be selected in some horses, thereby reducing the number of diagnostic biopsies required. This would be anticipated to have direct positive effects on surgical time and morbidity. Surgery time was not quantified in this review, preventing more objective analysis on this point, yet no horses undergoing 1 to 2 biopsies suffered either systemic or wound healing complications. Laparoscopic examination also allows visual assessment of the dorsal abdomen and biopsy of abnormal masses / mesenteric lymph nodes that may not be feasible by flank laparotomy.

Incisional complications afflicted three horses and is widely recognised as a risk when performing flank laparotomy in horses. Graham and Freeman (2014) hypothesised that this is due to increased tissue trauma working in the tight space as the surgeon's arm is repeatedly inserted and withdrawn. All three horses affected in this series had undergone blind laparotomy without laparoscopic assistance, thereby creating a potential source of increased incisional trauma through repeated abdominal entries during the selection process. The most common reported indication for equine standing flank laparotomy has been for ovariectomy, where reported rates of incisional infection vary. A selection of studies from the last 15 years report infections as a proportion of laparotomies: 1/43 (2 %) De Bont et al (2010); 1/22 (5 %) Hanson and Galuppo (1999); 15/157 (10 %) Röcken et al (2011); and 6/55 (11 %) Lloyd et al (2007). Wound complications afflicted 3/15 horses (20 %) in this series. One reason for the increased incisional healing problems was that most (13/15) horses in this series received systemic corticosteroid administration to treat the underlying inflammatory bowel condition in the early postoperative period, including all 3 that developed infections. The small numbers in this case series prevented meaningful comparison, but no horses undergoing one or two biopsies developed incisional complications. This supports Graham and Freeman's (2014) hypothesis that time combined with increased surgical trauma increases risk of infection.

Gastric reflux due to postoperative ileus occurred following standing abdominal surgery, afflicting two horses in this series. This was anticipated in the acute colic case because advanced SIRS was already present and surgery was carried out in a 'last resort' scenario. Oral decompression of the distended bowel could not be performed. However, it also occurred in an elective laparotomy in one horse affected by weightloss. This horse had 4 biopsies taken, which would have affected both surgical trauma and time. However, the two other horses that had 4 biopsies taken suffered no complications. Overall, this source of morbidity seems most likely to be related to the underlying condition, as opposed to being caused by the surgical technique.

Performing a standing approach for the purpose of small intestinal biopsy provides an additional

diagnostic technique whereby small intestinal biopsies can be taken without the need for general anaesthesia or advanced laparoscopic skills and equipment.

Indications for standing small intestinal resection and end-to-end anastomosis are rarely encountered; acute colic with intestinal distension has been suggested to be a contra-indication for standing surgery (Graham and Freeman 2014), although some authors recommend standing laparoscopic assessment where pain and logistics permit (Klohn 2012). This study confirms the inadvisability of this technique for acute strangulation, potentially due in large part to the practical impossibility of decompressing bowel oral to the obstruction. In one case in this series, standing intestinal resection and anastomosis proved successful, with surmountable difficulties when suturing a moving bowel, supporting the intestine and preventing exteriorisation of healthy adjacent bowel. Use of a Mayo instrument tray, appropriately draped and standing against the side of the horse, would have facilitated this part of the procedure by providing a small flat area to work on. Additional topical local anaesthesia was not needed for intestinal surgery in conscious sedated horses, despite the application of bowel clamps and sharp transection of bowel wall, as has been noted in man, e.g. Rogozov and Bemel 2009. This may be partly attributable to appropriate pre- and peri-operative analgesia. In addition, there are no proprioceptors in viscera and few touch or temperature receptors; pain receptors are present at much lower density than in somatic structures (Ganong 2005). Although hollow viscera are known to be particularly sensitive to distension, they may be much less sensitive to the sharp pain elicited during transection.

In conclusion, obtaining full-thickness small intestinal biopsies using an extra-abdominal technique was effective and safe. There was some indication that minimising the number of biopsies reduced morbidity, yet the underlying pathological process appeared to be the most important prognostic factor for survival. The small numbers of different types of inflammatory bowel disease made comparisons of survival meaningless. In a comfortable horse found to have a lesion amenable to resection and anastomosis, doing so under standing sedation was challenging but

feasible. However, based on the literature and our experience, we believe that making a standing approach in an acute colic for surgical bowel resection is neither safe for the horse, nor effective.

Manufacturers

1. Karl Storz Endoscopy (UK) Ltd, 392 Edinburgh Avenue, Slough, Berkshire, SL1 4UF, United Kingdom. Tel. 01753 503500.
2. Polysorb, Medtronic Ltd, 9 Hatters Lane, Watford, WD18 8WW, United Kingdom. Tel. 01923 212213.
3. Monocryl, Ethicon, Johnson and Johnson Medical Ltd, PO Box 1988, Simpson Parkway, Kirkton Campus, Livingstone, United Kingdom, EH54 0AB. Tel. 01506 594500.
4. Microsoft Excel, Microsoft Corporation, 1 Microsoft Way, Redmond, Washington, WA-98052-7329, USA. Tel. 425 882 8080.

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FIGURES

Figure 1. Having created the laparotomy, the surgeon's caudal hand was introduced into the abdominal cavity to select the section of intestine desired. H: surgeon's hand; J: jejunum. This case had undergone initial laparoscopy, allowing the biopsy section of small intestine to be selected visually, as well as by palpation.

Figure 2. Having exteriorised the section of small intestine to be biopsied, a routine full thickness antimesenteric biopsy was harvested using conventional surgical instrumentation.

Figure 3. In the horse found to have adenocarcinoma, the affected bowel was exteriorised and supported by the assistant surgeon in the same way as for biopsy.

Figure 4. Routine hand sewn end to end anastomosis was carried out.

Figure 5. One of the horses examined for weight loss was found to have a focal jejunal adenocarcinoma during laparoscopy. It was too thin and weak to be safely anaesthetised and therefore underwent resection and anastomosis during the same standing procedure.